NASA TECH BRIEF

Marshall Space Flight Center

Increasing Terminal Strip Efficiency at Cryogenic Temperatures

The problem:

Materials at liquid helium temperatures (~4 K) have such small heat capacities that a small power input raises their temperatures significantly. Thermal heat-sinking leads once relied on insulating varnish with thin paper or other dielectric to fasten the leads to a metal heat-sink block. The thermal conductivity of varnish is several orders of magnitude lower than that of metals and is therefore inefficient.

The solution:

A thermally-shorting, electrically-insulating terminal strip illustrated was developed after experimenting with sapphire posts that were used to heat-sink leads in integrated-circuit (IC) structures. Single-crystal sapphire and quartz have thermal conductivities equaling that of oxygen-free, high-conductivity (OFHC) copper at liquid helium temperatures. Either crystal can be used to fabricate thermally-shorting, electrically-insulating terminal boards.

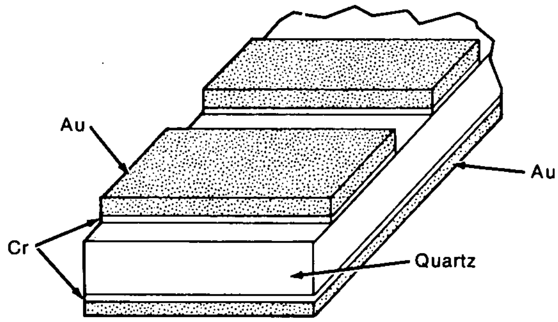

Figure 1.
After cleaning and scribing, the crystal is etched with chromium, then gold.

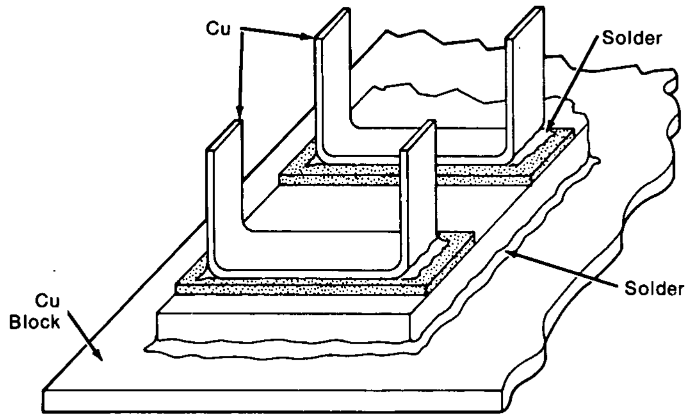

Figure 2.
Surface tension holds the copper staples erect after they are soldered to the strip.

(continued overleaf)

How it's done:

The crystals, approximately 21 mm square by 0.33 mm thick, are chemically cleaned, scribed with a diamond point, and broken into three 7-mm-width strips. The pieces are further cleaned by sputter etching. Then 250 to 1,000 Å of chromium followed by 5,000 to 20,000 Å of gold are sputtered onto each side. One side of each piece is masked longitudinally with 4-mm-width tape; exposed metal is removed by bead blasting. (See Figure 1.)

Using a hotplate, the pieces are soldered onto a copper block; the hotplate temperature is then lowered until the solder solidifies. Copper staples 2 mm wide by 0.4 mm thick are soldered onto the strips. When the solder wets the copper staples, surface tension pulls them erect and holds them in place. After all staples are in place, the hotplate is turned off and the unit is allowed to cool. (See Figure 2.)

The quartz strips can be soldered wherever needed. Superconducting terminals can also be built by replacing the copper staples with ones made from niobium foil with copper sputtering.

Notes:

1. Discarded AT-cut crystals can be recycled for this application by cleaning and resilvering them before fabricating the terminal boards.
2. Requests for further information may be made in writing to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Code AT01
   Marshall Space Flight Center, Alabama 35812
   Reference: B75-10266

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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Categories: 03 (Physical Sciences)
08 (Fabrication Technology)